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Sensor for determining composition of exhaust gas stream of vehicle comprises sensor elements in array which is applied to electrically non-conducting substrate

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NOVELTY - A sensor comprises several sensor elements (2) arranged in an array which is applied to an electrically non-conducting substrate (11) having a sensitive layer of semiconducting metal oxide and contact electrodes for measuring the resistance of the sensitive layer.

DETAILED DESCRIPTION - A sensor comprises several sensor elements (2) arranged in an array which is applied to an electrically non-conducting substrate (11) having a sensitive layer of semiconducting metal oxide and contact electrodes for measuring the resistance of the sensitive layer. The array has an heater (8). Several membrane (12) are formed in the substrate and are thermally decoupled by a bar (13) made of substrate material. A bar has a height which is more than the thickness of the membrane. A heater and a temperature sensor are arranged on each membrane and are separated from each other by insulating layers (9, 10). The sensor elements have a sensitive layer (3).

USE - For determining the composition of an exhaust gas stream of a vehicle.

ADVANTAGE - The sensor has a relatively large heat capacity.

DESCRIPTION OF DRAWING(S) - The drawing shows a cross-section through the sensor.

Sensor element (2)
Sensitive layer (3)
Heater (8)
Insulating layers (9, 10)
Membrane (12)
Bar (13)
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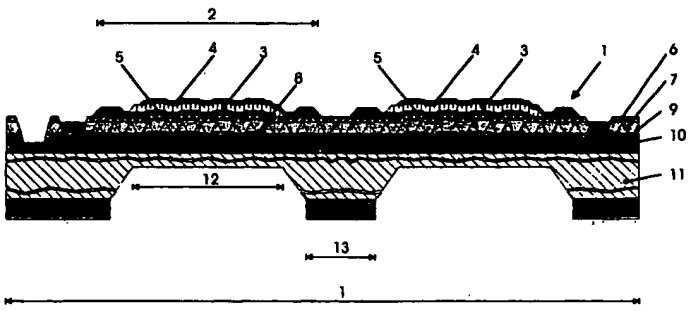
(54) SENSOR FOR DETERMINATION OF COMPOSITION OF GASES

(57) Sensor for determination of the composition of gases, with several sensor elements arranged in an array and which are mounted on an electrically nonconducting substrate, having at least one sensitive layer made of a semiconducting metal oxide and contact electrodes to measure the resistance of the sensitive layer, in which the array is provided with a heating arrangement, characterized by the fact that several membranes (12) are formed in substrate (11) that are thermally decoupled from each other by a connector (13) made of substrate material, in which one connector (13) has a height that is greater than the thickness of a membrane (12), that a heater (8) and a temperature sensor are arranged on each membrane (12), which are separated by each other by insulation layers (9, 10), and that a sensor element (2) with its own sensitive layer (3) is mounted above the heater/temperature sensor arrangement, separated by an additional insulation layer (6, 7).



Sensor for Determination of Composition of Gases

The invention concerns a sensor for determination of the composition of gases, with several sensor elements arranged in an array and which are mounted on an electrically nonconducting substrate. The sensor elements have at least one sensitive layer made of a semiconducting metal oxide and contact electrodes to measure the resistance of the sensitive layer. The array is provided with a heating arrangement.

This type of sensor is described in European Patent Application 0527 258 A1. This gas sensor array is used to determine individual components in a gas mixture. It consists of a number of individual sensor elements, each of which are mounted on an electrically nonconducting substrate and which consist of semiconducting metal oxides. The array is provided with a contact electrode arrangement to measure electrical conductivities. In addition, a heating arrangement to establish a predetermined operating temperature of the sensor array is provided.

Heating is then provided for each sensor element. This heating is arranged beneath the support layer. For thermal decoupling between the sensor elements, a heat barrier in the form of a tapering of the support layer is introduced. Because of this, individual operating temperatures can be set on the sensors and differences between the corresponding sensor signals are formed for detection of individual gas components. These differences are assessed in a processing unit.

It was found in this sensor that, on the one hand, not every sensor element is fully heat-decoupled from the adjacent sensor element. Consequently, a mutual temperature effect occurs. On the other hand, the arrangement of the heaters beneath the support layer means the temperature changes that are to be adjusted by the heaters are countered by a relatively large heat capacity. Consequently, this sensor is only conditionally suitable for use in gas composition measurements in the exhaust stream of vehicles, in which the gas composition can change very quickly.

The task of the invention consists of devising a sensor for determination of the composition of gases that is suitable for use in the exhaust stream of vehicles.

According to the invention, the task is solved in that several membranes are formed in the substrate that are thermally decoupled from each other by a connector of substrate material. A connector has a height that is greater than the thickness of a membrane. A heater and a temperature sensor are arranged on each membrane, which are separated from each other by insulation layers. The sensor element, separated by an additional insulation layer, is mounted above the heater/temperature sensor arrangement with its own sensitive layer.

Because of the arrangement of the sensor elements on the membrane, sufficient thermal decoupling of the individual sensor elements occurs, so that very different operating temperatures can be set between the individual sensor elements. In addition, the heater is only

separated from the sensor element by a relatively thin insulation layer and therefore acts very directly and without a high heat capacity on the sensor element. The measurement rate is therefore significantly increased. Finally, the proximity of the temperature sensor arrangement to the heater is decisive for very rapid control behavior of the heating arrangement.

In an expedient embodiment of the invention, it is prescribed that the heaters and temperature sensors consist of platinum.

In another embodiment, it is prescribed that the heaters and temperature sensors consist of different materials. In this case, it is expedient that at least one material consist of tungsten or platinum.

It has been found that it is particularly favorable when the sensitive layer consists of TiO_2 for use of the sensor, according to the invention, in the exhaust stream of vehicles.

In another embodiment of the invention, it is prescribed that the operating temperature of the sensor elements of the array can be adjusted in the range of 400°C to 540°C. The signal patterns significant for the exhaust stream in vehicles can be determined in this temperature range.

It is also expedient that the contact electrodes consist of platinum or gold.

The invention will now be further explained with reference to a practical example. The corresponding drawing shows a sectional view through a sensor chip according to the invention.

A sensor 1 consists of several sensor elements 2 that are arranged in an array. It has been found to be expedient to form the array, in a manner not further depicted, from 3 × 3 sensor elements 2, i.e., a total of nine sensor elements 2.

The sensor elements each have a sensitive layer 3 of TiO_2. To measure the resistance of the sensitive layer 3, two upper contact electrodes 4 are arranged above the sensitive layer 3 and two lower contact electrodes 5 are beneath the sensitive layer 3, in which the contact electrodes 4 and 5 lie beneath each other in the sectional view. These contact electrodes 4 and 5 consist of platinum. They can be connected for electrical conduction for signal analysis from the outside in a manner not further shown. Because of this, a resistance change of the sensitive layer can be recorded. Multivariant data analysis of the resistance change of all sensor elements then leads to [a determination of] the gas composition by means of a neuronal net or main component analysis.

A heater 8 is arranged, separated by a first insulation layer 6 and a second insulation layer 7, beneath the lower contact electrode 5. This heater 8 consists of platinum conducting tracks. The overall arrangement between heater 8 and upper contact electrode 4 is mounted on a silicon wafer as substrate 11, separated by a third insulation layer 9 and a fourth insulation layer 10.

This substrate 11 is formed as a membrane 12 beneath sensor elements 2. The membrane 12 is produced by the etching of substrate 11, so that a tapering of the substrate 11 to membrane

12 is produced during the etching process beneath sensor element 2. Connectors 13 remain during this etching process between membranes 12 of each sensor element, through which the membranes 12 are thermally decoupled.

Each sensor element 2 can therefore have its own operating temperature by means of heater 8. The resistance behavior of the sensitive layer 3, different at the different operating temperatures, is then evaluated in the manner just presented.

Temperature sensors (not further shown) that are components of a temperature control loop, together with the corresponding heaters 8, are also provided to control the operating temperature of each sensor element 2.

Sensor for Determination of Composition of Gases

List of reference numbers

1	Sensor
2	Sensor element
3	Sensitive layer
4	Upper contact electrode
5	Lower contact electrode
6	First insulation layer
7	Second insulation layer
8	Heater
9	Third insulation layer
10	Fourth insulation layer
11	Substrate
12	Membrane
13	Connector

Sensor for Determination of Composition of Gases

Claims

1. Sensor for determination of the composition of gases, with several sensor elements arranged in an array that are mounted on an electrically nonconducting substrate that has at least one sensitive layer made of a semiconducting metal oxide and contact electrodes to measure the resistance of the sensor layer, in which the array is provided with a heating arrangement, characterized by the fact that several membranes (12) are formed in substrate (11), which are thermally decoupled from each other by a connector (13) made of substrate material, in which a connector (13) has a height that is greater than the thickness of a membrane (12), that a heater (8) and a temperature sensor are arranged in each membrane (12), which are separated from each other by insulation layers (9, 10), and that a sensor element (2) with its own sensitive layer (3) is mounted above the heater/temperature sensor arrangement, separated by an additional insulation layer (6, 7).

2. Sensor according to Claim 1, characterized by the fact that the heater (8) and temperature sensor consist of platinum.

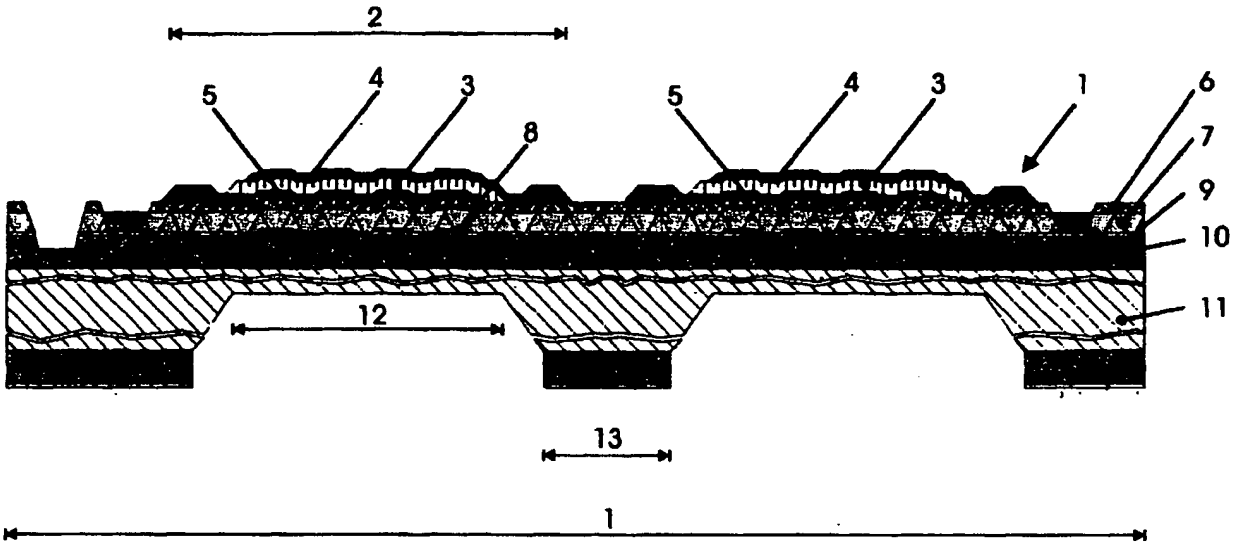
3. Sensor according to Claim 1, characterized by the fact that the heater (8) and temperature sensor consist of different materials.

4. Sensor according to Claim 3, characterized by the fact that at least one material consists of tungsten or platinum.

5. Sensor according to one of Claims 1 to 4, characterized by the fact that the sensitive layer (3) consists of TiO_2.

6. Sensor according to one of Claims 1 to 5, characterized by the fact that the operating temperature of the sensor element (2) of the array lies in the range of 400 to 540°C.

7. Sensor according to one of Claims 1 to 6, characterized by the fact that the contact electrodes (4, 5) consist of platinum or gold.



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